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A FLORISTIC DESCRIPTION AND STRUCTURAL ANALYSIS OF THE PLANT COMMUNITIES OF THE PUNDA MILIA—PAFURI—WAMBIYA AREA IN THE KRUGER NATIONAL PARK, REPUBLIC OF SOUTH AFRICA:

2. THE SANDVELD COMMUNITIES

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Abstract

The Sandveld communities of the Punda Milia-Pafuri-Wambiya area in the Kruger National Park are described floristically and structurally. Habitat factors such as aspect, slope, soil, geology and altitude are discussed briefly. The floristic classification of the communities was done by means of the Braun-Blanquet method and the communities are described in terms of the most conspicuous as well as the differential species in the woody and herbaceous strata. The structural analysis was done by means of the Variable Quadrant Plot method and the discussion of the structure of the communities is based on the different growth forms, their canopy spread in different strata and the number of individuals per hectare.

Uittreksel

'N FLORISTIESE BESKRYWING EN STRUKTURELE ANALISE VAN DIE PLANTGEMEENSKAPPE VAN DIE PUNDA MILIA-PAFURI-WAMBIYA-GEBIED IN DIE NASIONALE KRUGERWILDTUIN, REPUBLIEK VAN SUID-AFRIKA:

2. DIE SANDVELDGEMEENSKAPPE

Die Sandveldgemeenskappe van die Punda Milia-Pafuri-Wambiya-gebied in die Nasionale Krugerwildtuin, wat onderskeidelik deur middel van die Braun-Blanquetmetode en Varieerbare Kwadrantperseelmetode gemonster is, word aan die hand van hul floristiese samestelling en struktuur bespreek. Daar word kortliks na habitatkenmerke soos aspek, helling, grond, geologie en hoogte bo seespieël verwys. Die floristiese klassifisering van die verskillende gemeenskappe word aan die hand van die opvallendste en differensiërende spesies van die houtagtige en kruidagtige stratums beskryf. Die strukturele beskrywing is veral op die verskillende groeivorme, hul kroonverspreiding in verskillende stratums en die aantal individue per hektaar gegrond.

Introduction

The Punda Milia-Pafuri-Wambiya area is situated in the northern part of the Kruger National Park and is bordered by Zimbabwe to the north and Mozambique to the east. The study area falls within the Transvaal Lowveld (L) climatic

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region of the South African Weather Bureau (Schulze, 1965) and according to the Köppen classification has a warm arid climate with a dry winter and a mean annual temperature exceeding 18 °C. The mean annual rainfall and temperature of Punda Milia and Pafuri are 549,1 mm; 22,9 °C and 415,2 mm; 24,2 °C respectively (Schulze, 1947; Weather Bureau, 1954, 1965; Reparticao tecnica de estatistica, 1961). In the preceeding paper (Van Rooyen, Theron and Grobbelaar, 1981a) environmental factors such as topography, drainage, geology, soils and climate were discussed in more detail.

To formulate a conservation and management policy, the emphasis must be on proper land use and for this purpose a classification of the vegetation is essential. Animal species differ in their habitat preferences and it is therefore important to locate the geographical distribution of these animal habitat types. Several factors determine the suitability of a habitat for a particular animal species, for example availability of food and visibility. Both these factors depend on floristic composition as well as vegetation structure. Relevant structural features include canopy regime and density of the various species at different height levels.

The objectives of this study were to classify the vegetation according to the Braun-Blanquet method (Werger, 1974) and to analyse the structure of the vegetation by the Variable Quadrant Plot method (Coetzee and Gertenbach, 1977).

METHODS

The Braun-Blanquet method, which was used in this study, is presently used in South Africa as basis for botanical surveys. The use of a uniform surveying method ensures comparable results and makes a hierarchical classification of the vegetation possible (Bredenkamp, 1975). This method has already been applied successfully on South African vegetation by Van Zinderen Bakker Jr. (1971); Coetzee (1972); Werger (1973); Bredenkamp (1975) and Boucher (1977) amongst others. The descriptive phrase included in the name of each community is based on the physiognomic vegetation classification of Tinley (1969).

For the structural analysis of the woody vegetation the Variable Quadrant Plot method was used (Van Rooyen *et al.*, 1981a). For each individual plant in the sample plot the species name, growth form, trunk diameter at ground level (if >100 mm), maximum height and the maximum canopy diameter in different strata were recorded. From the data the canopy spread and density of each plant species as well as each height class in the sample plot, were calculated. The canopy spread was expressed as a percentage of the sample plot area and density as number of individuals per hectare. The different strata that were investigated are: 0,5 m; 1 m; 2 m; 3 m; 4–5 m and >6 m (Van Rooyen *et al.*, 1981a). The height class to which an individual belongs corresponds to the stratum in which the highest plant material of that individual occurs. The three growth forms which were distinguished are as follows:

tree — individual with a single stem;
sparse shrub — individual with two to four stems; and
shrub — individual with more than four stems.

The field data were processed using computer programs. Tables were compiled for each sample plot and the mean values calculated for all the plots within a particular plant community. The following discussion is based on the latter values.

The total percentage canopy spread for a given stratum is obtained by

(a) measuring the maximum canopy diameter of each specimen within that stratum on each sampling plot;
(b) calculating a circular canopy cross-sectional area for each individual plant from the values referred to above;
(c) calculating the sum of all the canopy cross-sectional areas of the given stratum referred to above for each sampling plot;
(d) expressing each of the last mentioned figures as a percentage of the surface area of the relevant sampling plot; and
(e) calculating the average value of the last mentioned values for the various sampling plots within a community.

The percentage apparent canopy cover (p.a.c.) is calculated as canopy cross-sectional area by using the largest canopy diameter measurement for each individual. The canopy cover for each group of individuals of the same species, growth form and height class is then calculated. This value is given as a percentage of the surface area of the sampling plot for the height class of that group. The total percentage canopy cover is then computed for each species and an average value of the latter values for the various sampling plots within a community is thus established.

RESULTS AND DISCUSSION

The classification of the vegetation in the study area stresses the correlation between habitat and floristic composition of communities as well as relationships between communities. Floristic composition and floristic relationship are shown in Table 1.

Differences and variations in the vegetation can often be ascribed to differences in geological formation, soil depth and rockiness of the soil surface, while climate, slope, pH of the soil, soil texture, soil structure, consistency and the concentration of salts in the soil all probably play a major role in the distribution of the plant communities.

The Sandveld communities are mainly found in areas underlain by Water berg Sandstone, Cave Sandstone as well as the light red to white sands of the

TABLE 1

A constancy table of the plant communities of the Punda Milia—Pafuri—Wambiya area in the Kruger National Park*

		COMMUNITIES																
		SANDVELD						COLOPHOSPERMUM MOPANE						DIABASE	HYGROPHILOUS			
	PLANT SPECIES	1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
A	*Burkea africana*	5																
	Fimbristylis hispidula	3			1	1	1						1					
	Andropogon gayanus	3					1						1					
	Holarrhena pubescens	3																
	Bauhinia galpinii	3				1												
	Ochna pulchra	2		1														
B	*Baphia massaiensis*		5															
	Grewia microthyrsa		3															
	Combretum celastroides		3				1											
	Hugonia orientalis		3	1														
	Ptaeroxylon obliquum		2															
	Pavetta catophylla		2															
	Cleistanthus schlechteri		2															
	Mariscus sp.		2															
	Heinsia crinita	1	2															
	Xylia torreana		1															
C	*Xeroderris stuhlmannii*			3														
	Aristida junciformis	1		2														
	Aristida stipitata	1		3	1													
	Indigofera inhambanensis	1		2														
	Limeum dinteri			2	1									2				
	Macrotyloma axillare			2			1											
	Pavonia burchellii			2									1					
	Balanites maughamii		1	2		1								2				
D	*Terminalia sericea*	3	2	5	4													
	Combretum collinum	3	2	4	3	1								3				
	Tricholaena monachne	2	2	3	1	1			1	1	1		1					
	Merremia tridentata	4	3	3	3			1	1									
	Crotalaria sphaerocarpa	1	1	2	3	1			1			1	1					
	Perotis patens	3	3	3	3													
	Pteleopsis myrtifolia	3	3	2	1	1												
	Eragrostis pallens	2	4	2	2													
	Zygoon graveolens	1	2	3	3			1										
	Aristida argentea	2	2	1	1													

The constancy value of a plant species in a community is indicated by the following symbols: 1 (1–20 %); 2 (>20–40 %); 3 (>40–60 %) 4 (>60–80 %); 5 (>80–100 %)

*The complete differential table can be found in Van Rooyen (1978).

		COMMUNITIES																
		SANDVELD						COLOPHOSPERMUM MOPANE						DIABASE	HYGROPHILOUS			
	PLANT SPECIES	1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
	Vitex amboniensis	1	2	1	1		1						1					
	Vangueria infausta	1	2	2	1													
	Striga asiatica	2	1		2													
	Xeromphis obovata	1	1		2													
	Hippocratea crenata		1		2	1												
	Acrotome inflata				2													
	Blepharis subvolubilis			1	2													
E	*Kirkia acuminata*			1	1	5				2			1					
	Rhoicissus revoilii		1		1	3	1											
	Croton gratissimus		2			3	2											
	Afzelia quanzensis					3	1											
	Bridelia mollis					2												
	Maytenus mossambicensis	1				2												
	Indigofera lupatana					1												
	Landolphia kirkii					1												
	Asparagus falcatus		1			1												
	Canthium huillense					1												
	Rhus leptodictya					1												
	Lagynias dryadum					1												
	Elephantorrhiza burkei					1								2				
	Brachylaena huillensis					1												
F	*Androstachys johnsonii*				1		5											
	Sporobolus panicoides					1	4											
	Croton pseudopulchellus	1				1	4											
	Commelina benghalensis				1	1	3		1				1					
	Achyranthes sicula						3											
	Setaria ustilata						2											
	Leptocarydion vulpiastrum				1		2											
	Cymbosetaria sagittifolia						2			1								
	Selaginella dregei						2											
	Panicum heterostachyum						2											
	Barleria galpinii						1											
	Panicum deustum						1					1						
	Merremia pinnata						1											
	Cyperus amabilis		1				1											
G	*Pellaea viridis*	2				3	2											
	Pellaea calomelanos					2	2											
	Phyllanthus reticulatus				1	2	2		1		1							
	Corchorus longipedunculatus					1	1											
	Xerophyta retinervis					1	1											
	Cleome monophylla					1	1											
	Xerophyta equisetoides					1	1											

	PLANT SPECIES	COMMUNITIES																
		SANDVELD						COLOPHOSPERMUM MOPANE						DIABASE	HYGROPHILOUS			
		1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
H	*Combretum zeyheri*	3	2	1	3	3	1											
	Borreria scabra	1	2	3	1	1	2											
	Pogonarthria squarrosa	4	2	2	3	2	1		1				2					
	Strychnos decussata	1	2	1	1	1	1											
	Pseudolachnostylis maprouneifolia	5	1	1	2	2												
	Hexalobus monopetalus	2	3	1	1	2												
	Strychnos madagascariensis	3	2	4	3	3			1		3		1					
	Ipomoea magnusiana	2	2	4	2		2	1	1				1					
	Guibourtia conjugata	2	5	2		2												
	Rhynchosia resinosa		2	3	1	2				1								
	Triumfetta pentandra	1		1	2	1	2		1									
	Diplorhynchus condylocarpon	4			1	3	1											
	Alchornea laxiflora	1	4			2	1											
	Monodora junodii	2	2		1	3	1											
	Celosia trigynia	1	2			2	2		1									
	Waltheria indica	2	2		2	3	1		1	1			2					
	Hymenocardia ulmoides	2	2			3	1											
	Cassia absus	1			2	1	1											
	Blepharis maderaspatensis	1			1	2	2											
	Tephrosia elongata	2	1	2	1	1			1									
	Rhynchosia venulosa	1	1	2		1	1											
	Artabotrys brachypetalus	1	1	1	1	2						1						
	Agathisanthemum bojeri	2	2		1	1			1									
	Tephrosia longipes	2		1	1	1							1					
	Crabbea velutina	1		2		1	1		1					2				
	Hippocratea longipedunculata		1	1	1	1												
	Ximenia caffra	1			1													
	Ozoroa paniculosa	1			1	1						1						
	Ozoroa engleri			1	1													
I	*Urochloa mosambicensis*				1			5	1		1	1	2			4	2	
	Chloris virgata				1			4	1	1						2		
	Acacia tortilis							3	1								2	1
	Salvadora angustifolia							2		1								
	Boerhavia diffusa							2										1
	Azima tetracantha							2										
	Alternanthera pungens							1										
	Trianthema triquetra							1										
	Setaria verticillata							1										
	Acacia senegal					1		1										
	Cyathula crispula							1										
J	*Ximenia americana*			1	1			1	4									
	Enteropogon macrostachyus					1	2	1	3	1								

		COMMUNITIES																
		SANDVELD						COLOPHOSPERMUM MOPANE						DIABASE	HYGROPHILOUS			
	PLANT SPECIES	1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
	Tetrapogon tenellus							1	2									
	Chloris roxburghiana							1	2									
	Acacia grandicornuta							2	1									
	Amaranthus thunbergii							1	1									
K	*Commiphora glandulosa*					1		2	1	3		1						
	Abutilon fruticosum					1	1	2	2	2								
	Ecbolium revolutum							2	2	2								
	Sporobolus smutsii	1			1	1		2	1	1								
	Thilachium africanum				1			2	1	1				2				
	Corbichonia decumbens							1	1	2								
	Sporobolus fimbriatus								1	1								
	Aristida rhiniochloa								1	1								
L	*Enneapogon scoparius*										5							
	Euclea schimperi				1						4							
M	*Terminalia prunioides*							1	3	2	3							
	Maerua parvifolia				2	1		3	3	2	1			2				
	Seddera capensis							1	2	3	5	1	1					
	Elytraria acaulis								2	2			1					
	Zanthoxylum capense							1	1	2	2							
N	*Themeda triandra*								1			5		2				
	Neorautanenia amboensis								1	1		4						
	Setaria woodii							1	1	1		3						
	Urochloa brachyura								1			2						
	Panicum coloratum											2			3			
O	*Heteropogon contortus*	1				1			1	2	4	4	2	2		2		
	Bothriochloa insculpta							1	2	3		4		2		2		1
	Phyllanthus maderaspatensis								1	2	2	1	1					
	Fingerhuthia africana								1	2	3	1	2					
	Indigofera heterotricha								1	2	1	2	1					
	Sorghum versicolor								1	2		3	1					
	Heliotropium strigosum				2					2		2	1					
	Oropetium capense								1	1	1	1	1					
P	*Colophospermum mopane*				2	1		3	5	5	5	5	5		5	4		
	Euclea divinorum	1			1			1	3	1	2		1		5	3		
	Aristida congesta subsp. *barbicollis*				1			1	2	3	2	3	2					
	Neuracanthus africanus					1		1	2	4	1	1	2					
	Barleria lancifolia					1		1	2	2	2		1					
	Eragrostis rigidior		1		1	1		1	1		2	2	1					

	COMMUNITIES																
	SANDVELD						COLOPHOSPERMUM MOPANE						DIABASE	HYGROPHILOUS			
PLANT SPECIES	1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
Eragrostis superba							1	1	1	2	4	1					1
Combretum hereroense					1			1	1	1	1		3		2		1
Dicoma tomentosa							1	1	1		1	1					
Dalechampia galpinii								1	2								
Aptosimum lineare								1	2								
Sterculia rogersii					1				1	2		1					
Q *Combretum apiculatum*	2	2	5	4	5	1	1	1	5	4	2	5					
Aristida congesta subsp. *congesta*	1	2	3	3	2	2	3	4	5	5	3	3					
Indigofera vicioides	1	3	1	1	1	1	1	2	3	4	2	2	2				
Cissus lonicerifolius	1	2	2	2	1	1	1	1	3	1	2	2					
Hermannia glanduligera	3	2	1	3	2	1	1	1	1		2	1	3				
Rhynchosia totta	3	1	2		1	1	1	1	3	3	2	2	3				
Phyllanthus burchellii	1	5	3	1	1	3		1	3		1	2	2				
Hibiscus engleri	2	2	2	2	2	2	2	1		1	1	1			2		
Brachiaria nigropedata	2	3	1	3	1	1		1	1		2	2					
Vigna unguiculata	3	2	4	4	1	1	1	1			2	2					
Commelina africana	2		2	1	1	1	2	1			1	1					
Acalypha indica	1		1	2	1	1	2	1	2	2	1	1	2				
Boscia albitrunca	1	1	2	3	2	1	1	1	1			2					
Commelina erecta	2	3	1	2	2	1	2	1	1			2					
Monechma monechmoides		1	3	2	1	2	1	1	3		1	1					
Enneapogon cenchroides	1		1	3	2	1	3	4	5	2	2	2					
Phyllanthus pentandrus	1		1	1	1	1	1	2	1	4	1	3					
Tephrosia polystachya	1	2	5	3	1	1		1	3	3	2	3					
Cassia abbreviata	1	1	1		1	1			1		1	1					
Schmidtia pappophoroides	2	2	4	4	1			2	2		3	4					
Hibiscus sidiformis		1	1	1	1	2	1	1	2			2					
Kyphocarpa angustifolia	1	1	1	1	3			1	2	1		2					
Grewia bicolor	1		2	2	2	1	3	4	4	4	2	3	2				
Dalbergia melanoxylon	2		4	3	1		1	1	1	4	3	2					
Pseudobrachiaria deflexa		2			1	3	2	1	3		1	1					
Pupalia lappacea	1			2	2	3	3	1	2				2				
Evolvulus alsinoides	1	1	1	2	2	1		1	3	2		1					
Tragus berteronianus			1	1	1		3	1	1	1	1	1					
Cassia mimosoides	1			2		1		1			2	1					
Euphorbia polycnemoides	1			1	3	1		1	3	2	1	2					
Crotalaria virgulata		1	1	1		1		2	1			2					
Euphorbia tettensis	2		3	2				1	3	1	1	2					
Maytenus heterophylla			1		1		1	1	1	4	1						
Cucumis anguria				2		1	1	1	1		1		2				
Corchorus asplenifolius	1			3		1	1		2	2	1	1	2	3			
Lantana rugosa	2		1		1	1			1			2					
Tricalysia allenii	1	1		1	2				1			1					

	COMMUNITIES																
	SANDVELD						COLOPHOSPER-MUM MOPANE						DIABASE	HYGRO-PHILOUS			
PLANT SPECIES	1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
Ipomoea obscura				1		1	2	1	1		1	1					
Grewia monticola			3	1	1	1		1			1						
Mundulea sericea	1		1	1	1				1		1						
Cymbopogon excavatus					1				1	1	2	1	3		2		
Markhamia acuminata				2	1				1		1	1					
Gardenia resiniflua				1	1	1	1	1	1								
Justicia protracta	1							1	1								
Barleria affinis					1				1								
Stylochiton natalensis	1				1	1		1									
Eragrostis curvula				1				1				1					
Ipomoea pes-tigrides	1	2		1			1	1									
Zornia diphylla	1	2		1	1				1			1					
Clerodendron ternatum	1		1	1				1	1	1	1	1					
Justicia flava					1		1	1				1					
Manilkara mochisia	1			1	1			1									
Rhynchosia minima	1							1			1	1					
Eragrostis heteromera				1			1		1								
Grewia hexamita		1	1	1	1	1			1		1		2				
Gisekia africana				1			2				1						
Commiphora edulis					1	1			1								
Anisotes sessiliflorus		1			1		1	1	1								
Cardiospermum halicacabum					1			1									
Aspilia mossambicensis	1								1			1					
Dactyloctenium aegyptium				1			1										
Polygala wilmsii	2		1		1				1		1						
Calostephane divaricatum				1	1			1	1								
Hermbstaedtia odorata	1							1		1		1					
Kyllinga alba	1					1		1			1	1					
Kohautia virgata	2						1	1		1		1					
Gardenia spatulifolia			1	1		1											
Cissus quadrangularis					1	1	1	1									
Stipagrostis uniplumis	1			1				1		1							
Eragrostis lehmanniana				1			1	1									
Leptactinia benguelensis		1	1		1	1		1									
Ipomoea crassipes											1						
Orthosiphon suffrutescens								1	1								
Grewia villosa					1	1	1		1		1						
Lippia javanica								1	1		1		2				
Merremia palmata											1	1					
Endostemon tenuiflorus									1	1							
R *Setaria holstii*													4	3	2		
Piliostigma thonningii													3				
Hyparrhenia rufa													3				
Helichrysum miconiifolium													3				

		COMMUNITIES																
		SANDVELD						COLOPHOSPERMUM MOPANE						DIABASE	HYGROPHILOUS			
	PLANT SPECIES	1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
	Ipomoea papilio						1							3				
	Acacia gerrardii											1		2				
S	*Acacia borleae*														5			
	Tetrapogon mossambicensis								1						5			
	Cephalocroton mollis											1			5			
	Ruellia patula				1			1	1	1		1	1		5			
	Brachiaria erucaeformis														3			
T	*Sesbania sesban*															4		
	Fuirena pubescens															3		
U	*Acacia albida*																5	
	Ficus sycomorus																4	
	Acacia robusta																4	
	Trichilia emetica																4	
	Diospyros mespiliformis																4	
	Hypoëstes verticillaris																3	
	Abutilon angulatum																3	
	Tabernaemontana elegans	1				1											3	
V	*Setaria sphacelata*									1			1	2	3	3		3
	Ischaemum afrum														5	4		2
	Ischaemum brachyatherum														3	2		1
	Panicum meyerianum															4	3	4
	Echinochloa pyramidalis															3	2	2
	Acacia xanthophloea																3	1
	Sporobolus consimilis																2	2
	Xanthocercis zambesiaca																3	1
	Kigelia africana																2	1
	Cyperus fenzelianus																	2
	Croton megalobotrys																	1
	Chloris gayana	1																1
W	*Panicum maximum*	4	5	5	5	4	3	5	4	4	1	3	4	2		4	5	3
	Digitaria eriantha	5	4	5	5	5	2	1	3	4	4	5	5	2	3	3	4	
	Hibiscus micranthus	1	1	2	2	3	3	3	4	5	3	1	4			2		
	Lonchocarpus capassa	1	1		3	1	1	1	1			2		3		4	4	2
	Spirostachys africana	1	3	1	1	1		1	2							4		1
	Combretum imberbe				1			1	1	1	1	3	1	2		3	3	2
	Solanum panduraeforme	2			2	2	2	1	2	2	1	2	3			2		1
	Dichrostachys cinerea	2	3	1	3	2	1	1	1	2	2	2	3	4		2		1
	Combretum mossambicensis	1	2	2	3	1	1	1	1	2	1		2	2				1
	Acacia nigrescens	1			2	2		2	3	3	4	2	4	3		4		
	Securinega virosa		2	1	1	1		1	1	1		1	1		5			1

PLANT SPECIES	COMMUNITIES																
	SANDVELD						COLOPHOSPERMUM MOPANE						DIABASE	HYGROPHILOUS			
	1.1	1.2	1.3	1.4	2.1	2.2	1.1	1.2	1.3	2.1	2.2	3	4	1.1	1.2	1.3	1.4
Vernonia fastigiata	4			1	2	2	1	1	2	1	3	1		5			
Cenchrus ciliaris			1					1	2		2	1					1
Achyranthes aspera	1			1	1	3	1	1	1							5	1
Indigofera rhytidocarpa	1	1		2			3	1	1	2	1	1					
Lannea stuhlmannii		2	1	1			1	1	1		1	1			2		
Leucas glabrata	1		1	2	1	1	1	1	2								1
Melhania forbesii	1	1	3	2	1			2	1	1	1	2					1
Monechma divaricatum			1	2			1	1									
Sclerocarya caffra	1	1	2	1	1				1		1	1			2		
Rhynchelytrum villosum			1	2	1	2		1	2	3	1	1	2				
Commiphora mollis				2				1	2	2		1					
Becium obovatum				1		1	1	1	3			1					
Asparagus setaceus	1			1	1	2		2	1	1		1		3			
Corchorus kirkii		2	2	1	1			1	1		1	1			3		1
Tragia rupestris	1		1	1	1			1	1		1	2			2		1
Grewia flavescens		2		1	1	1		1								2	
Maytenus senegalensis				1									2				1
Leonotis nepetifolia	2			1	1	1							2				1
Pterocarpus rotundifolius											1		2				
Ceratotheca triloba				1			1		1		1				2		
Barleria transvaalensis							1	1	1								
Peltophorum africanum	2				1			1					2				
Hemizygia bracteosa	1	1	2	1	1					1		1			2		
Albizia harveyi									1		1	1			2		
Abutilon guineense				1	1		1	1	1					2			1
Ziziphus mucronata					1		1	1		1		1					1
Melhania rehmannii					1	1		1			1						1
Cyperus sp.					1		1	1		1					2		
Ormocarpum trichocarpum								1			1		2		2		
Abutilon ramosum							1				1		2				1
Indigofera schimperi	1				1						1	1		3	2		
Cassia petersiana	1	1	1	1							1		2				

Quaternary period (Van Rooyen, 1978). These communities are jointly characterised by species group H (Table 1) and can be subdivided as follows:

1. The *Terminalia sericea—Pteleopsis myrtifolia* tree savanna
    1.1 The *Burkea africana—Pseudolachnostylis maprouneifolia* tree savanna
    1.2 The *Baphia massaiensis—Guibourtia conjugata* thicket
    1.3 The *Xeroderris stuhlmannii—Combretum apiculatum* tree savanna
    1.4 The *Terminalia sericea—Pogonarthria squarrosa* tree savanna

2. The *Croton gratissimus—Phyllanthus reticulatus* tree savanna
    - 2.1 The *Kirkia acuminata—Afzelia quanzensis—Combretum apiculatum* tree savanna
    - 2.2 The *Androstachys johnsonii—Croton pseudopulchellus* dry forest

3. The Rocky Outcrop community

4. The Diabase community

The Rocky Outcrop (3) and Diabase community (4) were only described physiognomically. The four communities of the first group (paragraphs 1.1, 1.2, 1.3, 1.4) are found mainly on the plains with deep sandy soils which are characterised by the following factors: low pH, leached deep sandy soil, high electrical resistance and a low percentage of stone covering. The altitude is normally higher than that of the surrounding *Colophospermum mopane* communities. The two communities of the second group (2.1, 2.2) are characterised by the following habitat factors: shallow, rocky, sandy soil and moderate to steep slopes. The pH and electrical resistance of the soil varies greatly.

The Rocky Outcrop community (3) is characterised by hills and inselbergs built up of Cave Sandstone while the Diabase community (4) is found on diabasic sills characterised by a dark red-brown clay soil.

1. The *Terminalia sericea——Pteleopsis myrtifolia* tree savanna. The four communities (paragraphs 1.1, 1.2, 1.3 and 1.4) within this savanna are characterised by species groups A, B, C and D respectively (Table 1). These communities are related to each other by the mutual presence of species group D. Community 1.4 is distinguished from communities 1.1, 1.2 and 1.3 by the absence or poor representation of species groups A, B and C (Table 1).

The habitat of the following four communities are characterised in general by the following factors:

Community 1.1: Red-brown fine textured sandy soil on the plains and on rocky north-facing slopes.
Community 1.2: Deep red coarse textured sandy soil, strongly leached, with a very low pH, and stones absent on the soil surface.
Community 1.3: } The habitat of these two communities are very similar. Fine to
1.4: } medium textured brown sandy soil with a low pH and with stones normally absent on the soil surface.

A prominent feature within community 1.3 is the large number of pans such as Shirombe, Magwitsi, Wambiyane, Matlakuza and Klawer pan that occur in the western part (Van Rooyen *et al.*, (1981a).

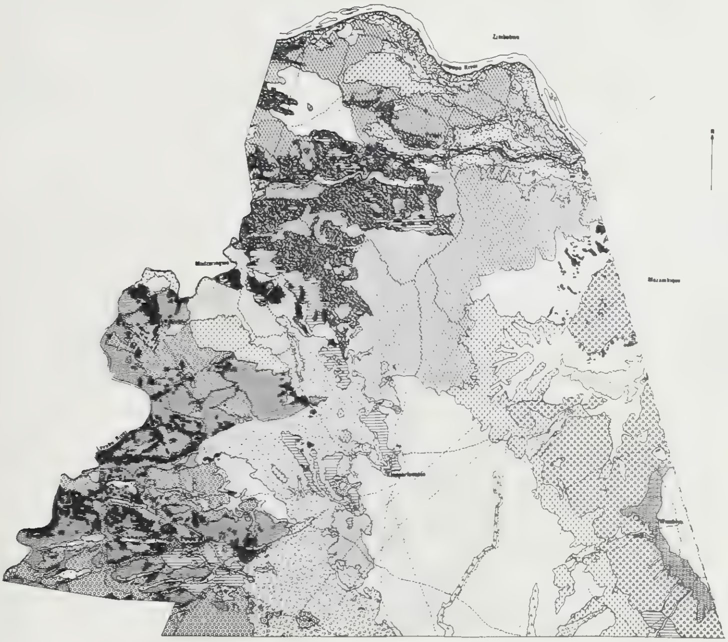

FIG. 1.
Vegetation map of the Punda Milia—Pafuri—Wambiya area in the Kruger National Park.

1.1 The *Burkea africana—Pseudolachnostylis maprouneifolia* tree savanna

This community occurs mainly on Waterberg Sandstone at 400 to 555 m above sea level on plains and on slopes with a gradient up to 10 ° and covers the broken country around Punda Milia, from the Levubu River in the west to Xantangelane in the east. This community usually occurs on the plains and on the north-facing slopes which are warmer and drier than the south facing slopes (Figs 1 & 2).

The Waterberg Sandstone weathers to a red brown to a dark red-brown fine textured sand or loamy sand. The soil layer varies from 30 mm to more than 1 m deep. Up to 60 % of the soil surface is covered by stones and the topsoil is apedal with a loose consistency. The pH of the strongly leached to normal soil ranges from 5,2 to 6,2. Carbonates are usually absent.

⦾ BURKEA AFRICANA–PSEUDOLACHNOSTYLIS MAPROUNEIFOLIA TREE SAVANNA

BAPHIA MASSAIENSIS–GUIBOURTIA CONJUGATA THICKET

▒ BAPHIA MASSAIENSIS–GUIBOURTIA CONJUGATA THICKET

▤ BAPHIA MASSAIENSIS–XYLIA TORREANA TREE SAVANNA

△ XERODERRIS STUHLMANNII–COMBRETUM APICULATUM TREE SAVANNA

⁝ TERMINALIA SERICEA–POGONARTHRIA SQUARROSA TREE SAVANNA

KIRKIA ACUMINATA–AFZELIA QUANZENSIS–COMBRETUM APICULATUM TREE SAVANNA

▦ KIRKIA ACUMINATA–AFZELIA QUANZENSIS TREE SAVANNA

≋ COMBRETUM APICULATUM–KIRKIA ACUMINATA TREE SAVANNA

■ ANDROSTACHYS JOHNSONII–CROTON PSEUDOPULCHELLUS DRY FOREST

✕ ROCKY OUTCROP COMMUNITY

▓ MIXED ROCKY OUTCROP COMMUNITY AND ANDROSTACHYS JOHNSONII–CROTON PSEUDOPULCHELLUS DRY FOREST

COLOPHOSPERMUM MOPANE–ACACIA TORTILIS–UROCHLOA MOSAMBICENSIS TREE SAVANNA

∘ ACACIA TORTILIS TREE SAVANNA

⁘ ACACIA SENEGAL SHRUB SAVANNA

● SALVADORA ANGUSTIFOLIA SHRUB SAVANNA

▒	COLOPHOSPERMUM MOPANE–EUCLEA DIVINORUM–ENTEROPOGON MACROSTACHYUS TALL TREE SAVANNA
▩	COLOPHOSPERMUM MOPANE–COMMIPHORA GLANDULOSA–SEDDERA CAPENSIS OPEN TREE SAVANNA
░	COLOPHOSPERMUM MOPANE–ENNEAPOGON SCOPARIUS SHRUB SAVANNA
▨	COLOPHOSPERMUM MOPANE–THEMEDA TRIANDRA SHRUB SAVANNA
✚ ✚	COLOPHOSPERMUM MOPANE–COMBRETUM APICULATUM–DIGITARIA ERIANTHA OPEN TREE SAVANNA
Z Z	DIABASE COMMUNITY
▦	ACACIA BORLEAE–ISCHAEMUM AFRUM SHRUB THICKET
S S	COMBRETUM IMBERBE–FUIRENA PUBESCENS OPEN TREE SAVANNA
▓	ACACIA ALBIDA–FICUS SYCOMORUS RIVERINE FOREST
	ACACIA XANTHOPHLOEA–PANICUM MEYERIANUM OPEN TREE SAVANNA
V V	ACACIA XANTHOPHLOEA OPEN TREE SAVANNA
ψ ψ	SPOROBOLUS CONSIMILIS GRASSLAND
≋	PAN COMMUNITIES
⟋	INTERNATIONAL BORDERS
┄	ROADS
〰	RIVERS

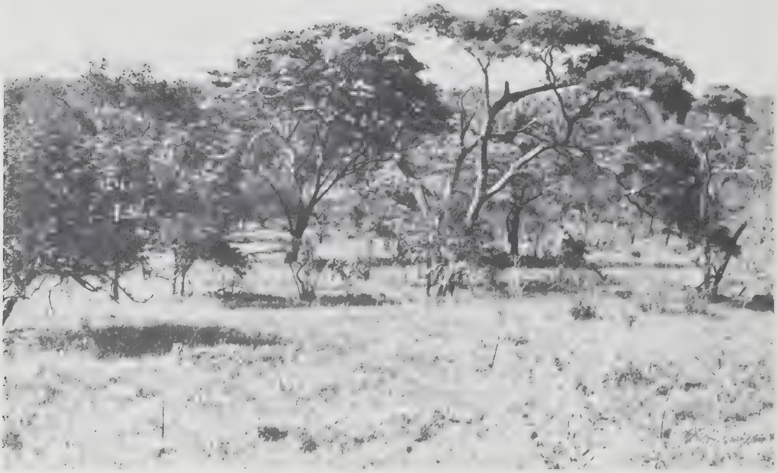

FIG. 2.
The *Burkea africana—Pseudolachnostylis maprouneifolia* tree savanna on Waterberg Sandstone.

Floristic composition

Trees, among which *Burkea africana, Pteleopsis myrtifolia* and *Pseudolachnostylis maprouneifolia* are the most striking, grow up to 10 m high. Shrubs and sparse shrubs reach up to 3 m and include species such as *Hymenocardia ulmoides, Xylopia odoratissima, Bauhinia galpinii, Diplorhynchus condylocarpon* and *Pteleopsis myrtifolia*. Two species, namely *Ochna pulchra* and *Holarrhena pubescens* are characteristic for this community only. In the study area the latter species together with *Burkea africana* are restricted to this community. Other conspicuous woody species are *Combretum collinum, C. zeyheri, Hexalobus monopetalus, Peltophorum africanum, Monodora junodii* and *Dalbergia melanoxylon*. A few species with a tropical distribution such as *Acacia polyacantha* subsp. *campylacantha, Xylopia odoratissima, Crossopteryx febrifuga* and *Drypetes gerrardii* (Van Wyk, 1972, 1974) are found in this community. *Pterocarpus angolensis, Heteropyxis natalensis, Turraea nilotica, Peltophorum africanum, Manilkara mochisia, Combretum molle* and *Cryptolepis oblongifolia* are less conspicuous, yet occur scattered throughout this community.

The herbaceous component is dominated by *Andropogon gayanus* and *Fimbristylis hispidula*, while *Digitaria eriantha* and *Panicum maximum* often grow in association with them. Other widespread herbaceous species in this community are *Pogonarthria squarrosa*, *Tricholaena monachne*, *Eragrostis pallens*, *Aristida argentea*, *Hermannia glanduligera*, *Brachiaria nigropedata* and *Vigna unguiculata*.

Structure

The structural analysis of the woody component of the community is given in Tables 2 and 3 as well as in Figures 9 and 10.

The highest total percentage canopy spread is found in the 2 m stratum, while the values for the 1 m and 3 m strata are also relatively high (Table 2). In the strata above 3 m the canopy spread is relatively low. The total percentage canopy spread in the 2 m stratum (13,83 %) can mainly be attributed to species of the 3 m height class (6,22 %). Up to the 3 m stratum, shrubs have the highest total percentage canopy spread. In the 2 m stratum *Hymenocardia ulmoides*, *Bauhinia galpinii*, *Diplorhynchus condylocarpon* and *Pteleopsis myrtifolia* have high percentage canopy spread values, while in the >6 m stratum *Pseudolachnostylis maprouneifolia*, *Burkea africana* and *Pteleopsis myrtifolia* have a relatively high percentage canopy spread (Table 3).

Most of the individuals up to 3 m are shrubs or sparse shrubs whereas the higher height classes are dominated by trees (Table 2). *Pseudolachnostylis maprouneifolia* (2,46 %) and *Bauhinia galpinii* (2,32 %) have the highest percentage apparent canopy cover while *Holarrhena pubescens* (273 indiv/ha) and *Diplorhynchus condylocarpon* (110 indiv/ha) have the highest densities (Table 3).

1.2 The *Baphia massaiensis—Guibourtia conjugata* thicket

This thicket is situated on the eastern border of the Kruger National Park, from south of Shirombe to just south of Matlakuze Pan and stretches westwards more or less to Wambiya Pan (Figs 1 & 3). This community lies on a sandy plateau between 475 and 532 m above sea level. The medium to coarse-textured sandy soil is brown, dull brown to dark red-brown in colour and deeper than 1 m. Stones seldom appear on the soil surface. The strongly leached topsoil is apedal with a loose consistency and has a pH ranging from 4,3 to 5,5. Carbonates are absent in the topsoil.

Floristic composition

In those parts where *Baphia massaiensis* and *Guibourtia conjugata* are the most abundant species a dense thicket 3 to 4 m high is formed. The western parts of the community is a tree savanna with species such as *Afzelia quanzensis* becoming up to 10 m high. Other widespread species are *Xylia torreana*, *Combretum celastroides*, *Hugonia orientalis*, *Pteleopsis myrtifolia*, *Vitex amboniensis*,

TABLE 2.

Percentage canopy spread in different strata and the mean number of individuals per hectare (indiv/ha) in different height classes of woody plant species in the *Burkea africana—Pseudolachnostylis maprouneifolia* tree savanna.

Stratum (m)	Percentage canopy spread										Mean number of indiv/ha				
	Total*	Growth form			Height class						Height class (m)	Total	Growth form		
		Tree	Sparse shrub	Shrub	>6	4–5 m	3 m	2 m	1 m	0,5 m			Tree	Sparse shrub	Shrub
>6	2,38	2,08	0,25	0,05	2,38						>6	19	15	4	
4–5	4,90	2,78	1,57	0,55	2,16	2,74					4–5	72	33	27	12
3	10,20	2,90	3,54	3,76	1,10	3,86	5,24				3	214	49	93	72
2	13,83	2,30	4,72	6,81	0,27	1,93	6,22	5,41			2	480	146	189	145
1	12,92	1,89	3,75	7,28	0,08	0,71	3,71	5,29	3,13		1	542	171	219	152
0,5	9,05	0,96	2,39	5,70	0,03	0,26	1,72	3,15	2,37	1,52	0,5	825	233	387	205
											Total	2 152	647	919	586

*Figures in this column are referred to in the text as "Total percentage canopy spread" values.

TABLE 3.

Percentage canopy spread in different strata; mean number of individuals per hectare (indiv/ha) and the percentage apparent canopy cover (p.a.c.) of a few species* in the *Burkea africana—Pseudolachnostylis maprouneifolia* tree savanna.

Plant species*	p.a.c.	indiv/ha	Percentage canopy spread					
			Stratum (m)					
			>6	4–5	3	2	1	0,5
Pseudolachnostylis maprouneifolia	2,46	69	0,73	1,42	1,48	0,88	0,60	0,44
Bauhinia galpinii	2,32	81			0,60	1,40	1,60	1,40
Hymenocardia ulmoides	2,21	101		0,13	1,35	2,06	1,48	0,75
Pteleopsis myrtifolia	2,16	76	0,37	0,51	0,97	1,05	0,84	0,38
Diplorhynchus condylocarpon	2,08	110	0,06	0,17	0,63	1,36	1,37	1,08
Holarrhena pubescens	1,84	273		0,32	0,40	0,51	0,81	0,66
Burkea africana	1,39	94	0,51	0,39	0,37	0,32	0,27	0,18
Heteropyxis natalensis	1,05	25			0,95	0,75	0,53	0,13
Terminalia sericea	0,79	28	0,17	0,32	0,22	0,33	0,22	0,04
Combretum collinum	0,79	51	0,04	0,23	0,24	0,50	0,38	0,16

*Only the ten species with the highest percentage apparent canopy cover (p.a.c.).

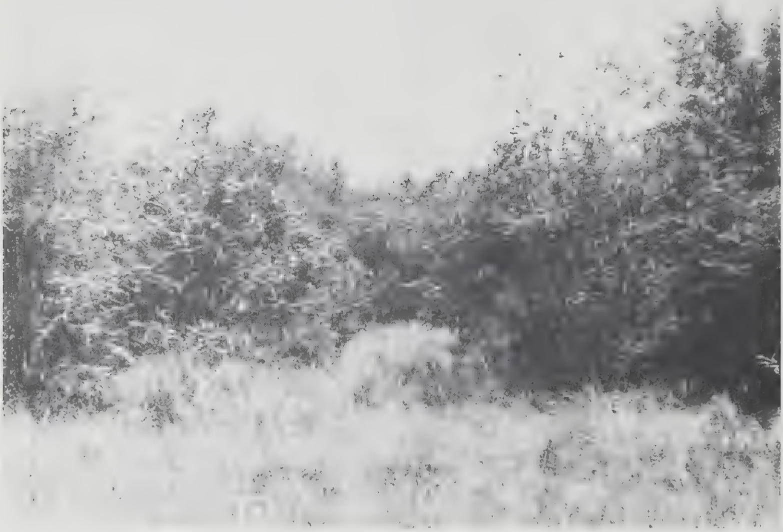

FIG. 3.
The *Baphia massaiensis—Guibourtia conjugata* thicket in the Wambiya area.

Alchornea laxiflora, Grewia microthyrsa, Ptaeroxylon obliquum, Heinsia crinita, Zygoon graveolens and *Strychnos madagascariensis*.

The *Baphia massaiensis—Guibourtia conjugata* thicket is an unique vegetation type. Tropical species such as *Baphia massaiensis, Drypetes mossambicensis, Pterocarpus lucens* subsp. *antunesii* and *Paropsia braunii* are found nowhere else within the Republic of South Africa. Other species with tropical affinities (Van Wyk, 1972) are: *Guibourtia conjugata, Hugonia orientalis, Pteleopsis myrtifolia, Xylia torreana* and *Cleistanthus schlechteri*. Some of the more widespread species are *Zanthoxylum davyi, Ochna* spp., *Ehretia amoena, Anisotes sessiliflorus, Boscia foetida* subsp. *rehmanniana* and *Conostomium zoutpansbergensis*.

In Figure 1 the community is subdivided into the *Baphia massaiensis–Guibourtia conjugata* thicket and the *Baphia massaiensis–Xylia torreana* tree savanna. Within the latter community *Balanites maughamii, Xylia torreana, Guibourtia conjugata, Spirostachys africana* and *Drypetes mossambicensis* are the most striking trees. Farrell (1968) described a related community in the vicinity of Malvernia in southeastern Zimbabwe with conspicuous species such as *Baphia massaiensis, Guibourtia conjugata, Pterocarpus lucens* subsp. *antunesii, Strychnos madagascariensis* and *Pteleopsis myrtifolia*.

The herbaceous component is poorly developed and herbs are often completely absent underneath the dense shrubs. *Eragrostis pallens, Digitaria eriantha* and *Panicum maximum* are the most important herbaceous species while *Phyllanthus burchellii, Merremia tridentata, Perotis patens, Commelina erecta, Borreria scabra* and *Tricholaena monachne* are frequently found.

Structure

The structural analysis of this community is given in Tables 4 and 5 as well as in Figures 9 and 10. The highest total percentage canopy spread is found in the 2 m stratum (26,32 %) while those of the 3 m stratum (19,78 %) and the 1 m stratum (19,18 %) are also relatively high (Table 4). The total percentage canopy spread of the remaining strata are relatively low. The high value for the 2 m stratum can be attributed mainly to species of the 3 m height class. The species contributing significantly to the canopy spread in the 2 m stratum are *Baphia massaiensis, Guibourtia conjugata* and *Combretum celastroides* (Table 5). Species of the >6 m height class do not contribute much to the canopy spread in the 0,5 and 1 m strata (Table 4).

Density remains more or less constant from the 0,5 m up to the 3 m height class, with a sharp decrease in the taller height classes. In spite of the large number of individuals in the 0,5 stratum, the total percentage canopy spread is

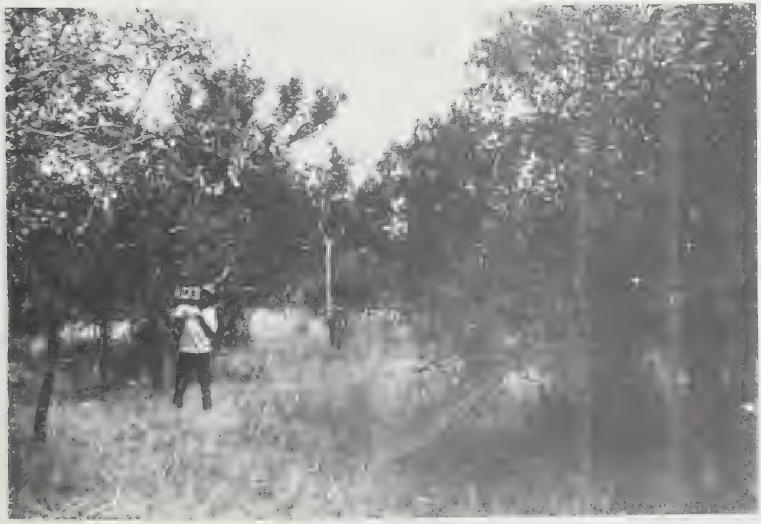

FIG. 4

The *Xeroderris stuhlmannii—Combretum apiculatum* tree savanna in the [illegible]

TABLE 4.

Percentage canopy spread in different strata and the mean number of individuals per hectare (indiv/ha) in different height classes of woody plant species in the *Baphia massaiensis—Guibourtia conjugata* thicket.

Stratum (m)	Percentage canopy spread										Mean number of indiv/ha				
	Total*	Growth form			Height class						Height class (m)	Total	Growth form		
		Tree	Sparse shrub	Shrub	>6 m	4–5 m	3 m	2 m	1 m	0,5 m			Tree	Sparse shrub	Shrub
>6	2,80	2,47	0,33		2,80						>6	22	17	5	
4–5	5,12	2,37	1,22	1,53	2,50	2,62					4–5	85	3	18	64
3	19,78	1,40	2,36	16,02	1,22	3,43	15,13				3	556	15	84	457
2	26,32	0,82	2,48	23,02	0,46	1,92	14,10	9,84			2	684	43	156	485
1	19,18	0,36	1,86	16,96	0,02	0,47	7,69	8,11	2,89		1	655	40	337	278
0,5	8,84	0,20	1,25	7,39	0,02	0,03	2,54	3,05	2,16	1,04	0,5	693	137	431	125
											Total	2 695	255	1 031	1 409

*Figures in this column are referred to in the text as "Total percentage canopy spread" values.

TABLE 5.

Percentage canopy spread in different strata; mean number of individuals per hectare (indiv/ha) and the percentage apparent canopy (p.a.c.) of a few species* in the *Baphia massaiensis—Guibourtia conjugata* thicket.

Plant species*	p.a.c.	indiv/ha	Percentage canopy spread					
			Stratum (m)					
			>6	4–5	3	2	1	0,5
Baphia massaiensis	9,47	326		0,33	5,04	8,02	6,09	2,48
Guibourtia conjugata	8,85	345	0,50	0,99	6,17	6,70	3,80	1,13
Combretum apiculatum	2,62	123	0,68	1,99	1,89	0,98	0,28	0,12
Ptaeroxylon obliquum	1,97	63			0,87	0,92	0,46	0,03
Combretum celastroides	1,95	88			0,39	1,53	0,98	0,31
Cleistanthus schlechteri	1,35	81				0,87	0,96	0,51
Combretum collinum	1,24	42		0,14	0,71	0,82	0,50	0,24
Spirostachys africana	1,15	8	1,03	1,04	0,27	0,11	0,01	
Dichrostachys cinerea	1,08	122			0,67	0,42	0,49	0,27
Hexalobus monopetalus	1,07	253				0,67	0,72	0,59

*Only the ten species with the highest percentage apparent canopy cover (p.a.c.).

low. Sparse shrubs are numerous in the 0,5 m and 1 m height classes, whereas the 2 m, 3 m and 4–5 m height classes are characterised mainly by shrubs (Table 4.)

Baphia massaiensis (9,47 % and 326 indiv/ha) and *Guibourtia conjugata* (8,85 % and 345 indiv/ha) have the highest percentage apparent canopy cover and density, while *Hexalobus monopetalus* (253 indiv/ha) is also present in large numbers (Table 5).

1.3 The *Xeroderris stuhlmannii—Combretum apiculatum* tree savanna

This tree savanna borders on the *Baphia massaiensis–Guibourtia conjugata* thicket to the east, the *Colophospermum mopane–Combretum apiculatum–Digitaria eriantha* open tree savanna to the west and the *Colophospermum mopane–Enneapogon scoparius* shrub savanna to the north. It occurs on a sandy plateau between 400 and 475 m above sea level (Figs 1 & 4).

The fine to medium textured sand to sandy loam soil is dark red-brown to dull brown and is more than 1 m deep. No stones are found on the surface and the strongly leached topsoil is apedal with a loose consistency. The pH ranges from 5,0 to 6,4 and carbonates are absent.

Floristic composition

Trees become up to 10 m high and the most abundant species are *Sclerocarya caffra*, *Xeroderris stuhlmannii* and *Combretum apiculatum*, while *Adansonia digitata* and *Afzelia quanzensis* are very conspicuous but occur more scattered. Shrubs and sparse shrubs, e.g. *Terminalia sericea*, *Combretum apiculatum* and *C. collinum* are 2 to 3 m high. Other associated woody species include *Dalbergia melanoxylon*, *Strychnos madagascariensis*, *Balanites maughamii*, *Guibourtia conjugata*, *Vangueria infausta*, *Grewia monticola* and *Boscia albitrunca*. Characteristic species in the herbaceous stratum are *Aristida stipitata*, *A. junciformis*, *Indigofera inhambanensis*, *Limeum dinteri*, *Macrotyloma axillare* and *Pavonia burchellii*. Associated species are *Digitaria eriantha*, *Tephrosia polystachya*, *Schmidtia pappophoroides*, *Vigna unguiculata* and *Tricholaena monachne*.

The community covers the biggest part of the Wambiya area and a characteristic feature is the large number of termitaria occurring locally. Species such as *Spirostachys africana*, *Diospyros mespiliformis*, *Euclea divinorum*, *Capparis tomentosa*, *Panicum maximum*, *Chloris roxburghiana and Cenchrus ciliaris* thrive on these termitaria. Farrell (1968) described a related community in southeastern Zimbabwe which is characterised by *Combretum apiculatum* and the associated species are *Pteleopsis myrtifolia*, *Strychnos madagascariensis*, *Afzelia quanzensis*, *Xeroderris stuhlmannii*, *Sclerocarya caffra* and *Pseudolachnostylis maprouneifolia*.

TABLE 6.

Percentage canopy spread in different strata and the mean number of individuals per hectare (indiv/ha) in different height classes of woody plant species in the *Xeroderris stuhlmannii—Combretum apiculatum* tree savanna

Stratum (m)	Total*	Percentage canopy spread								
		Growth form			Height class					
		Tree	Sparse shrub	Shrub	>6 m	4–5 m	3 m	2 m	1 m	0,5 m
>6	0,59	0,40	0 13	0,06	0,59					
4–5	3,59	1,15	1,62	0,82	0,78	2,81				
3	8,45	2,37	3,94	2,14	0,56	3,11	4,78			
2	9,71	1,69	4,41	3,61	0,14	1,81	4,54	3,22		
1	7,02	0,80	2,71	3,51	0,01	0,51	2,35	2,87	1,28	
0,5	4,20	0,22	1,22	2,76		0,21	0,81	1,42	1,09	0,67

Mean number of indiv/ha				
Height class (m)	Total	Growth form		
		Tree	Sparse shrub	Shrub
>6	10	7	3	
4–5	74	22	42	10
3	180	50	94	36
2	323	99	128	96
1	252	47	97	108
0,5	498	29	271	198
Total	1 337	254	635	448

*Figures in this column are referred to in the text as "Total percentage canopy spread" values.

Table 7.

Percentage canopy spread in different strata; mean number of individuals per hectare (indiv/ha) and the percentage apparent canopy cover (p.a.c.) of a few species* in the *Xeroderris stuhlmannii—Combretum apiculatum* tree savanna.

Plant species*	p.a.c.	indiv/ha	Percentage canopy spread					
			Stratum (m)					
			>6	4–5	3	2	1	0,5
Combretum apiculatum	4,68	231	0,15	1,85	3,34	2,96	1,34	0,36
Terminalia sericea	2,40	114	0,07	0,68	2,13	1,93	1,01	0,36
Combretum collinum	1,25	58		0,01	0,54	0,85	0,76	0,50
Pteleopsis myrtifolia	0,90	122		0,11	0,19	0,41	0,40	0,47
Strychnos madagascariensis	0,81	169	0,03	0,06	0,41	0,57	0,44	0,22
Dalbergia melanoxylon	0,68	122		0,01	0,14	0,58	0,47	0,25
Guibourtia conjugata	0,55	20	0,06	0,09	0,17	0,33	0,40	0,21
Pseudolachnostylis maprouneifolia	0,45	18	0,04	0,24	0,34	0,29	0,20	0,08
Dalbergia nitidula	0,29	6			0,17	0,29	0,18	0,11
Sclerocarya caffra	0,29	14	0,11	0,26	0,17	0,01	0,01	0,02

*Only the ten species with the highest percentage apparent canopy cover (p.a.c.).

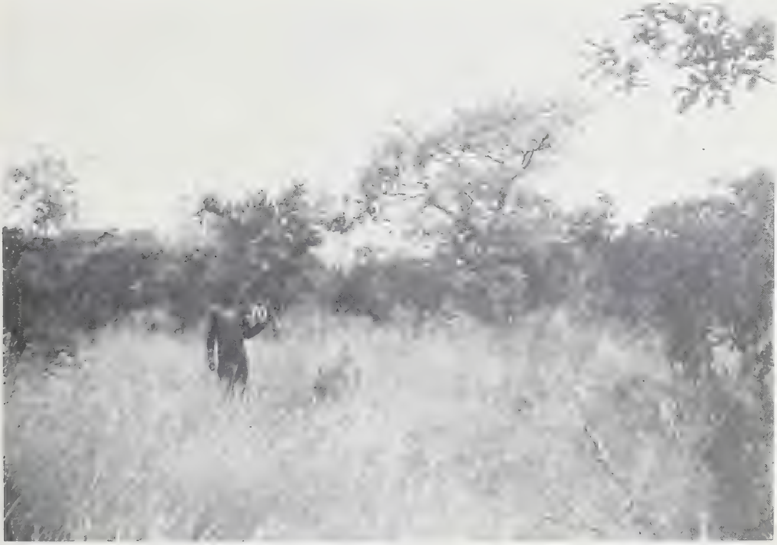

FIG. 5.
The *Terminalia sericea—Pogonarthria squarrosa* tree savanna on deep sandy soils.

Structure

The structural analysis of this community is given in Tables 6 and 7 as well as in Figures 9 and 10. The 2 m and 3 m strata have the highest total percentage canopy spread (Table 6). Species such as *Combretum apiculatum, Terminalia sericea* and *Combretum collinum*, contribute considerably to these values (Table 7). In the 0,5 m and 1 m strata shrubs have the highest total percentage canopy, whereas sparse shrubs have the highest values in the 2 m and 4–5 m strata (Table 6).

The highest density is found in the 0,5 m, 1 m and 2 m height classes. Sparse shrubs are most numerous in the 0,5 m and 2 m height classes, whereas shrubs are most numerous in the 1 m height class.

Only a few trees and sparse shrubs occur in the >6 m height class (Table 6).

Species with high percentage apparent canopy cover values are *Combretum apiculatum* (4,68 %) *Terminalia sericea* (2,40 %) and *Combretum collinum* (1,25 %) while high densities were calculated for *Combretum apiculatum* (231 indiv/ha), *Strychnos madagascarienis* (169 indiv/ha), *Pteleopsis myrtifolia* (122 indiv/ha) and *Dalbergia melanoxylon* (122 indiv/ha) (Table 7).

1.4 The *Terminalia sericea*—*Pogonarthria squarrosa* tree savanna

This savanna lies at 305 to 475 m above sea level in the Punda Milia area, the northwestern Cave Sandstone area and in parts of the Wambiya Sandveld. It is found on plains, plateaus and on moderate western, southern and northeastern slopes with a gradient up to 6° (Figs 1 & 5).

The community occurs on Waterberg Sandstone, Cave Sandstone, shale and aeolian sand. The fine to medium-textured brown to dark brown sand, to sandy loam soil varies from 120 mm to more than 1 m deep. Up to 20 % of the soil surface may be covered with stones. The topsoil is apedal, has a loose consistency, is strongly leached and has a pH between 5,4 and 6,3. Carbonates are locally present in low concentrations.

Floristic composition

Most of the trees are 4 to 7 m high with a few reaching up to 12 m. Conspicuous tree species are *Terminalia sericea, Lannea stuhlmannii, Kirkia acuminata* and *Sclerocarya caffra*. In the 2 m and 3 m strata the most important shrubs and sparse shrubs are *Combretum collinum, Xeromphis obovata, Combretum zeyheri* and *Strychnos madagascariensis*. Associated species include *Combretum apiculatum, Hippocratea crenata, Dalbergia melanoxylon, Boscia albitrunca, Lonchocarpus capassa, Dichrostachys cinerea* and *Combretum mossambicensis*.

The presence of species such as *Terminalia sericea, Combretum collinum, Strychnos madagascariensis* and *Xeroderris stuhlmannii* in the Pafuri area indicate the affinities between this community and the *Xeroderris stuhlmannii*–*Combretum apiculatum* tree savanna. Physiognomically and structurally these two communities are very similar.

The herbaceous component is characterised by *Panicum maximum* and *Digitaria eriantha* with high canopy cover values, as well as by *Schmidtia pappophoroides, Crotalaria sphaerocarpa* and *Pogonarthria squarrosa*. A few species such as *Vigna unguiculata, Brachiaria nigropedata, Merremia tridentata, Tephrosia polystachya, Hermannia glanduligera* and *Perotis patens* are found scattered throughout the community.

Structure

The structural analysis of the woody component of the community is given in Tables 8 and 9 as well as in Figures 9 and 10.

The highest total percentage canopy spread is found in the 2 m stratum (11,39 %). Species of the 3 m height class contribute the most to this value. The highest total percentage canopy spread in the strata up to 2 m is due to shrubs, in the 3 m stratum it is sparse shrubs and in the 4–5 m and >6 m strata it is trees, that contribute most to the total percentage canopy spread. Species of the >6 m stratum contribute little to the 0,5 m, 1 m and 2 m strata (Table 8). In the 2 m and 3 m strata *Combretum apiculatum, C. collinum* and *Terminalia sericea*

TABLE 8.

Percentage canopy spread in different strata and the mean number of individuals per hectare (indiv ha) in different height classes of woody plant species in the *Terminalia sericea—Pogonarthria squarrosa* tree savanna.

Stratum (m)	Percentage canopy spread										Mean number of indiv/ha				
	Total*	Growth form			Height class						Height class (m)	Total	Growth form		
		Tree	Sparse shrub	Shrub	>6 m	4–5 m	3 m	2 m	1 m	0,5 m			Tree	Sparse shrub	Shrub
>6	1,93	1,74	0,16	0,03	1,93						>6	14	11	3	
4–5	4,16	2,32	1,06	0,78	1,83	2,33					4–5	57	17	25	15
3	8,53	2,08	3,42	3,03	0,78	3,24	4,51				3	161	31	74	56
2	11,39	1,32	4,32	5,75	0,29	1,94	5,18	3,98			2	279	57	109	113
1	9,52	0,83	3,68	5,01	0,05	0,76	3,17	3,94	1,60		1	346	88	177	81
0,5	6,98	0,35	2,27	4,36	0,02	0,26	1,59	2,36	1,09	1,66	0,5	396	60	197	139
											Total	1 253	264	585	404

*Figures in this column are referred to in the text as "Total percentage canopy spread" values.

TABLE 9.

Percentage canopy spread in different strata; mean number of individuals per hectare (indiv/ha) and the percentage apparent canopy cover (p.a.c.) of a few species* in the *Terminalia sericea—Pogonarthria squarrosa* tree savanna.

Plant species*	p.a.c.	indiv/ha	Percentage canopy spread					
			Stratum (m)					
			>6	4–5	3	2	1	0,5
Combretum apiculatum	3,43	155	0,10	1,14	2,30	2,16	1,03	0,37
Combretum collinum	2,75	62	0,04	0,40	1,54	2,09	1,63	1,06
Terminalia sericea	2,23	57	0,32	0,91	1,09	1,01	0,71	0,30
Hippocratea crenata	1,64	100				0,12	0,16	1,58
Pteleopsis myrtifolia	1,24	48		0,22	0,72	0,98	0,53	0,22
Combretum zeyheri	1,21	67		0,11	0,67	0,92	0,67	0,41
Strychnos madagascariensis	0,70	112			0,13	0,49	0,57	0,39
Grewia bicolor	0,57	31			0,05	0,41	0,53	0,29
Dalbergia melanoxylon	0,43	86			0,01	0,16	0,26	0,26
Boscia albitrunca	0,37	21	0,04	0,11	0,23	0,08	0,07	0,08

*Only the ten species with the highest percentage apparent canopy cover (p.a.c.).

have high total percentage canopy spread values, while *Terminalia sericea* has the highest value in the >6 m stratum (Table 9).

Plants of the 0,5 m height class have the highest density and the density decreases progressively up to the >6 m height class (Table 8). *Combretum apiculatum* (155 indiv/ha) and *Strychnos madagascariensis* (112 indiv/ha) attain high densities in the community (Table 9) whereas *Combretum apiculatum* (3,43 %), *C. collinum* (2,75 %) and *Terminalia sericea* (2,23 %) have high percentage apparent canopy cover values.

2. The *Croton gratissimus—Phyllanthus reticulatus* tree savanna

This tree savanna is characterised by species groups E, F & G. It occurs on steep rocky slopes and in "kloofs" in the sandstone areas of the Waterberg and Karroo Systems, as well as on the Malvernia Formation south of Pafuri.

Two communities (2.1, 2.2) can be distinguished and are characterised by species group E and F respectively. The presence of species group G (Table 1) indicates affinities between the *Kirkia acuminata—Afzelia quanzensis—Combretum apiculatum* tree savanna (2.1) and the *Androstachys johnsonii—Croton pseudopulchellus* dry forest (2.2). The two communities often appear in association with each other on the same slope. The affinities of community 2.1 to the other Sandveld communities are shown by species groups G and H and the absence of species such as *Pseudolachnostylis maprouneifolia, Hexalobus monopetalus, Strychnos madagascariensis* and *Guibourtia conjugata* is noteworthy. Species group H also reveals the relationship between the *Croton gratissimus—Phyllanthus reticulatus* tree savanna (2) and the *Terminalia sericea—Pteleopsis myrtifolia* tree savanna (1).

The habitats of both these communities are very similar except that community 2.1 is mainly found on steep south-facing slopes whereas community 2.2 is not influenced by aspect. Both communities are charactertised by a shallow, stony, dark red-brown fine-textured soil.

2.1 The *Kirkia acuminata—Afzelia quanzensis—Combretum apiculatum* tree savanna

This community is found in the Punda Milia area between 305 and 555 m above sea level, mainly on steep south-facing slopes with a gradient up to 31 ° (Figs 1 & 6). The southern slopes are more cooler and moist than the northern slopes as a result of the moist south-eastern winds from the Indian ocean.

Weathering of the Waterberg and Cave Sandstone in this area results in a dark red-brown fine-textured loamy sand to sandy clay loam soil. In general the soil is shallow (100–300 mm deep) and 8 to 40 % of the soil surface is covered with stones. The soil is apedal with a loose consistency and has a pH of 4,8 to 7,2. In some places the soil is strongly leached and carbonates are locally present in a low concentration.

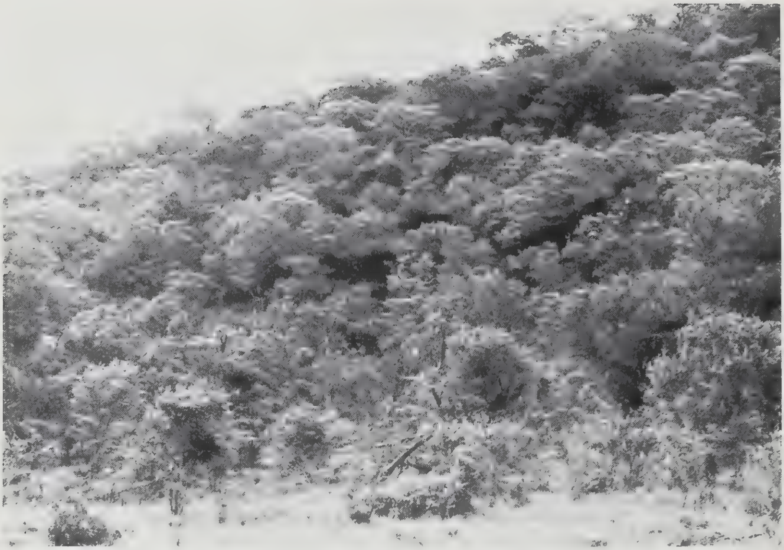

FIG. 6.
The *Kirkia acuminata—Afzelia quanzensis—Combretum apiculatum* tree savanna against a south-facing slope near Punda Milia.

Floristic composition

The trees become up to 12 m high and the conspicuous species are *Afzelia quanzensis, Kirkia acuminata, Croton gratissimus, Guibourtia conjugata* and *Combretum apiculatum*. Shrubs and sparse shrubs grow up to 3 m high and include species such as *Combretum apiculatum, Hymenocardia ulmoides, Diplorhynchus condylocarpon, Monodora junodii* and *Hexalobus monopetalus*. Species such as *Combretum zeyheri, Strychnos madagascariensis, Rhoicissus revoilii, Bridelia mollis, Phyllanthus reticulatus, Alchornea laxiflora, Maytenus mossambicensis* and *Artabotrys brachypetalus* occur widespread throughout the community.

Under the trees the herbaceous species have a low canopy cover but they are more dense in the open patches. Characteristic species are *Pellaea viridis, P. calomelanos, Euphorbia polycnemoides, Kyphocarpa angustifolia, Panicum maximum* and *Digitaria eriantha*. Other less common species are *Asparagus falcatus, Indigofera lupatana, Panicum deustum, Achyranthes sicula, Triumfetta pentandra* and *Crabbea velutina*.

A number of species showing tropical affinities occur in this community. These species, such as *Warburgia salutaris, Wrightia natalensis, Entandrophragma caudatum, Gyrocarpus americanus, Albizia tanganyicensis, Schrebera argyrotricha* and *Steganotaenia araliacea* are relatively scarce or absent in other parts of the Kruger National Park.

A number of species such as *Brachylaena huillensis, Elephantorrhiza burkei, Rhus leptodictya, Acacia erubescens, Landolphia kirkii* and *Canthium huillense* are not common, yet are often locally conspicuous. On the densely vegetated slopes and in the "kloofs" the following species are common:

Cussonia spicata
Ficus sansebarica
Urera tenax
Erythrina lysistemon
Pouzolzia hypoleuca
Strychnos usambarensis
Acacia ataxacantha
Vepris reflexa
Brachylaena huillensis
Heteropyxis natalensis

On the drier north-facing slopes this community differs from the savanna on the south-facing slopes. *Combretum apiculatum* is more striking on the north-facing slopes and as can be seen in Figure 1, the community can be subdivided into the *Kirkia acuminata—Afzelia quanzensis* tree savanna and the *Combretum apiculatum—Kirkia acuminata* tree savanna.

Structure

The structural analysis of this community is given in Tables 10 and 11 as well as in Figures 9 and 10. The vegetation up to a height of 3 m is dense (Table 10) and yields high total percentage canopy spread values for these strata: 14,85 % for the 3 m stratum, 14,50 % for the 2 m stratum and 11,20 % for the 1 m stratum. In the >6 m stratum the total percentage canopy spread is 4,25 % and it is composed of species such as *Kirkia acuminata* and *Afzelia quanzensis* (Table 11). Species of the 4–5 m and >6 m height classes have low percentage canopy spread values in the 0,5 m and 1 m strata (Table 10). In the lower strata, e.g. the 2 m stratum, *Combretum apiculatum, Croton gratissimus, Hymenocardia ulmoides* and *Diplorhynchus condylocarpon* have high percentage canopy spread values (Table 11).

The largest mean number of individuals per hectare, namely 814 indiv/ha, is found in the 0,5 m height class. In the higher height classes and in the >6 m class only 21 indiv/ha are found. Most of the individuals in the 0,5 m and 1 m height classes are sparse shrubs. Shrubs are relatively scarce except in the 2 m height class (Table 10). Species that occur in relatively high densities in this community are *Monodora junodii* and *Combretum apiculatum* (Table 11) and the species with relatively high percentage apparent canopy covers are *Combretum apiculatum* (8,60 %), *Croton gratissimus* (1,93 %), *Kirkia acuminata* (1,63 %) and *Guibourtia conjugata* (1,61 %) (Table 11).

TABLE 10.

Percentage canopy spread in different strata and the mean number of individuals per hectare (indiv/ha) in different height classes of woody plant species in the *Kirkia acuminata—Afzelia quanzensis—Combretum apiculatum* tree savanna.

Stratum (m)	Percentage canopy spread										Mean number of indiv/ha				
	Total*	Growth form			Height class						Height class (m)	Total	Growth form		
		Tree	Sparse shrub	Shrub	>6 m	4–5 m	3 m	2 m	1 m	0,5 m			Tree	Sparse shrub	Shrub
>6	4,25	3,91	0,34		4,25						>6	21	17	4	
4–5	11,06	4,38	5,79	0,89	2,63	8,43					4–5	190	75	97	18
3	14,85	4,06	8,32	2,47	0,98	8,45	5,42				3	217	59	122	36
2	14,50	3,02	7,38	4,10	0,20	3,53	5,19	5,58			2	550	197	213	140
1	11,20	2,30	5,44	3,46	0,05	0,75	3,02	5,55	1,83		1	618	233	318	67
0,5	6,77	1,04	3,46	2,27		0,16	1,04	2,99	1,38	1,20	0,5	814	218	517	79
											Total	2 410	799	1 271	340

*Figures in this column are referred to in the text as "Total percentage canopy spread" values.

TABLE 11.

Percentage canopy spread in different strata; mean number of individuals per hectare (indiv/ha) and the percentage apparent canopy cover (p.a.c.) of a few species* in the *Kirkia acuminata–Afzelia quanzensis–Combretum apiculatum* tree savanna.

Plant species*	p.a.c.	indiv/ha	Percentage canopy spread					
			Stratum (m)					
			>6	4–5	3	2	1	0,5
Combretum apiculatum	8,60	263	0,13	5,34	6,35	3,26	0,97	0,27
Croton gratissimus	1,93	162	0,05	0,61	1,06	0,85	0,76	0,43
Kirkia acuminata	1,63	4	1,62	0,59	0,16	0,02		
Guibourtia conjugata	1,61	47	0,26	0,93	1,16	0,75	0,45	0,09
Afzelia quanzensis	1,59	9	1,43	0,68	0,17	0,04		
Combretum zeyheri	1,34	69	0,07	0,65	0,69	0,46	0,33	0,10
Monodora junodii	1,10	415			0,15	0,53	0,78	0,63
Hymenocardia ulmoides	1,06	46			0,58	0,84	0,57	0,27
Diplorhynchus condylocarpon	1,00	42		0,12	0,46	0,80	0,74	0,60
Tricalysia allenii	1,00	60			0,02	0,72	0,83	0,47

*Only the ten species with the highest percentage apparent canopy over (p.a.c.).

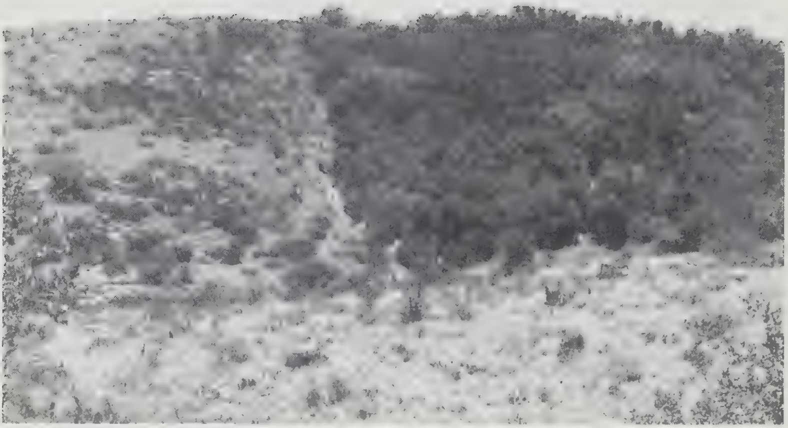

Fig. 7.
The *Androstachys johnsonii—Croton pseudopulchellus* dry forest occurring commonly on sandstone hills.

2.2 The *Androstachys johnsonii—Croton pseudopulchellus* dry forest

This dry forest is situated on areas underlain by Waterberg Sandstone, Cave Sandstone and the Malvernia Formation at 355 to 475 m above sea level on moderate to steep (up to 22°) rocky slopes (Figs 1 & 7). The fine to medium-textured sand to sandy clay loam soil is dark red-brown to brown-black. Rocks and stones cover up to 60 % of the soil surface, while the soil depth ranges from 100 to 250 mm. The topsoil is apedal with a loose consistency and has a pH between 4,8 and 8,3. The soil usually has a moderate concentration of soluble salts or is strongly leached in places. Carbonates can be found locally.

Floristic composition

Androstachys johnsonii, which grows up to 10 m high, is by far the most conspicuous species in this forest. *Entandrophragma caudatum, Euphorbia confinalis* and *Boscia albitrunca* are also abundant species. Adjacent communities are often sharply demarcated from the dry forest and an ecotone is not always present.

The shrub and sparse shrub components are not well developed. Among the species that reside in this community are *Croton pseudopulchellus, Phyllanthus* *reticulatus, Strophanthus kombe, Pouzolzia hypoleuca, Euphorbia espinosa, Dombeya kirkii, Monodora junodii, Vitex amboniensis* and *Alchornea laxiflora*.

The herbaceous component has a low cover value and the characteristic herbaceous species are *Sporobolus panicoides, Achyranthes sicula, Enteropogon macrostachyus, Setaria ustilata, Leptocarydion vulpiastrum, Celosia trigyna, Cymbosetaria sagittifolia* and *Selaginella dregei*. The associated species are *Danthoniopsis pruinosa, Panicum heterostachyum, Cleome monophylla, Corchorus longipedunculatus, Blainvillea gayana, Xerophyta equisetoides* and *X. humilis*.

A number of widespread species include *Commelina benghalensis, Pseudobrachiaria deflexa, Pupalia lappacea, Pellaea viridis, P. calomelanos, Asparagus setaceus* and *Blepharis maderaspatensis*. The absence of *Panicum maximum* and *Digitaria eriantha* is noteworthy.

Trees in this forest form an almost closed canopy leading to poorly developed shrub and herb layers. Termitaria with species such as *Boscia albitrunca, Achyranthes sicula, Urochloa mosambicensis, Panicum deustum, Capparis tomentosa* and *Sansevieria* spp. are occasionally found, mainly on the northeast-facing slopes.

Structure

In Tables 12 and 13 as well as in Figures 9 and 10 the structural analysis of the woody vegetation is set out.

Compared to the other Sandveld communities this dry forest has a unique structure. The total percentage canopy spread increases from the 0,5 m stratum to the 4–5 m stratum, which has the highest value (Table 12). The value for the 4–5 m stratum is only slightly higher than for the >6 m stratum. In the 0,5 m and 1 m strata sparse shrubs have the highest total percentage canopy spread, but from the 2 m to the >6 m strata trees contribute the most to the canopy spread values. *Androstachys johnsonii* has the highest percentage canopy spread in all the strata while *Croton pseudopulchellus* shows high values in the lower strata (Table 13). In the 0,5 m stratum the canopy spread is relatively low.

Densities do not vary much between height classes, the lowest density is found in the 3 m height class and the highest density in the 2 m height class. All in all there are more trees than shrubs and sparse shrubs, although sparse shrubs are more numerous in the lower strata. Shrubs are scarce in all height classes (Table 12).

Species with a relatively high percentage apparent canopy cover and density are *Androstachys johnsonii* (44,12 % and 1 900 indiv/ha) and *Croton pseudopulchellus* (3,7 % and 385 indiv/ha) (Table 13).

3. The Rocky Outcrop community

Hills and inselbergs built up of Cave Sandstone of the Karroo System are

TABLE 12.

Percentage canopy spread in different strata and the mean number of individuals per hectare (indiv/ha) in different height classes of woody plant species in the *Androstachys johnsonii—Croton pseudopulchellus* dry forest.

	Percentage canopy spread										Mean number of indiv/ha				
Stratum (m)	Total*	Growth form			Height class						Height Class (m)	Total	Growth form		
		Tree	Sparse shrub	Shrub	>6 m	4–5 m	3 m	2 m	1 m	0,5 m			Tree	Sparse shrub	Shrub
>6	27,75	25,54	2,21		27,75						>6	588	541	47	
4–5	30,28	25,08	5,20		19,58	10,70					4–5	448	373	75	
3	22,38	15,82	5,26	1,30	8,38	9,12	4,88				3	403	224	127	52
2	19,48	9,22	6,93	3,33	2,68	5,83	5,86	5,11			2	642	180	344	118
1	12,82	4,98	5,12	2,72	0,64	2,29	3,39	3,87	2,63		1	527	152	250	125
0,5	5,80	1,70	2,57	1,53	0,13	0,76	1,14	1,41	1,35	1,01	0,5	433	150	250	33
											Total	3 041	1 620	1 093	328

*Figures in this column are referred to in the text as "Total percentage canopy spread" values.

TABLE 13.

Percentage canopy spread in different strata; mean number of individuals per hectare (indiv/ha) and the percentage apparent canopy cover (p.a.c.) of a few species* in the *Androstachys johnsonii—Croton pseudopulchellus* dry forest.

Plant species*	p.a.c.	indiv/ha	Percentage canopy spread					
			Stratum (m)					
			>6	4–5	3	2	1	0,5
Androstachys johnsonii	44,12	1 900	23,50	27,51	20,26	13,78	7,20	2,98
Croton pseudopulchellus	3,71	385				1,66	2,49	1,33
Entandrophragma caudatum	1,78	22	1,78	0,44	0,02			
Croton gratissimus	1,41	165				0,71	1,07	0,57
Combretum apiculatum	1,01	22	0,02	0,23	0,83	0,69	0,14	
Boscia albitrunca	0,79	11	0,79	0,55				
Combretum zeyheri	0,77	15	0,72	0,67	0,81			
Cassia abbreviata	0,76	33	0,68	0,20			0,08	
Phyllanthus reticulatus	0,64	94				0,45	0,23	0,22
Diplorhynchus condylocarpon	0,50	11			0,46	0,50	0,35	0,09

*Only the ten species with the highest percentage apparent canopy cover (p.a.c.).

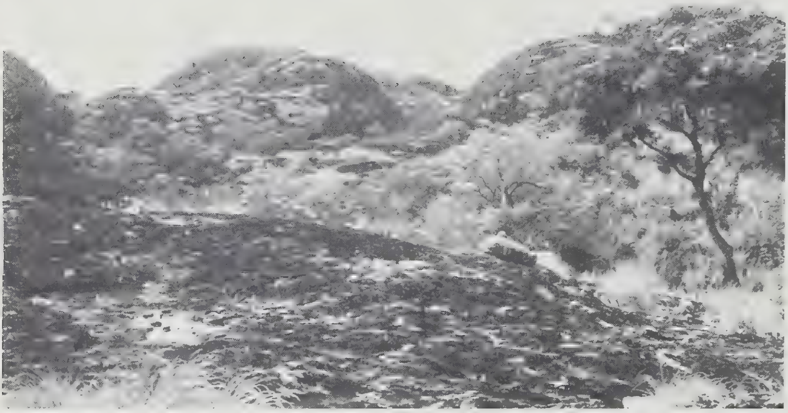

FIG. 8.
The Rocky Outcrop community on Cave Sandstone of the Karroo System.

found at, e.g. Hutwini, Mashikiri and Mukahanya. These outcrops are characterised by trees such as *Stadmannia oppositifolia* subsp. *rhodesica, Steganotaenia araliacea, Ficus* spp., *Boscia angustifolia* and *Diospyros lycioides* (Figs 1 & 8).

The physiognomic striking species are:
Ficus ingens
F. soldanella
F. tettensis
F. sonderi
Commiphora marlothii
Maerua angolensis
Ptaeroxylon obliquum
Gyrocarpus americanus
Euphorbia tirucalli
Rothmannia fischeri

Common sparse shrubs and shrubs include:
Antidesma venosum
Hippocratea crenata
Urera tenax
Vepris reflexa
Croton menyhartii
Drypetes gerrardii
Adenium obesum var. multiflorum
Hexalobus monopetalus

Widespread herbaceous species are:

Vahlia capensis
Thunbergia hirta
Tephrosia virgata
Ocimum canum
Jatropha messinica
Danthoniopsis pruinosa
Gloriosa superba
Coleochloa rehmanniana

In Figure 8 the pure form of this community is illustrated. In other areas, as illustrated in Figure 1, the Rocky Outcrop community occurs together with the *Androstachys johnsonii—Croton pseudopulchellus* dry forest.

4. The Diabase community

This community occurs in the Punda Milia Sandveld area on fine textured dark to very dark red-brown sandy clay loam to clay soil. It is found on diabasic sills west of Punda Milia at 475 to 520 m above sea level (Fig. 1). The most conspicuous woody species are *Acacia nigrescens, Combretum collinum, C. zeyheri, Dichrostachys cinerea, Pterocarpus rotundifolius, Bolusanthus speciosus* and *Dombeya rotundifolia*. Conspicuous herbaceous species are *Hyparrhenia rufa, Setaria holstii, Themeda triandra, Setaria sphacelata* and *Heteropogon contortus*.

COMPARISON OF STRUCTURE

Vegetation structure is defined by Dansereau (1951) as the organisation in space of the individuals that form a stand (and by extension a vegetation type or a plant association) and the primary elements of structure are growth form, stratification and coverage. Basically vegetation structure is therefore the distribution of biomass in space (Kershaw, 1964).

In Figures 9 and 10 diagrammatic presentations of the total percentage canopy spread and mean total number of individuals per hectare in the different strata and height classes respectively are given for the Sandveld communities.

In five of the six communities represented in Figure 9 the total percentage canopy spread follows more or less the same pattern. There is an increase from the 0,5 m to the 2 m or 3 m strata and above that stratum there is a progressive and pronounced decrease in the total percentage canopy spread values. Community 2.2 (Fig. 9) however, differs from the other five communities in that its total percentage spread values increase up to the 4–5 m stratum and has a high value for the >6 m stratum also.

Generally there are few individuals per hectare in the higher height classes (Fig. 10). The density of community 2.2 once again reveals a totally different pattern. Here a large number of individuals per hectare are found in the 4–5 m and >6 m height classes.

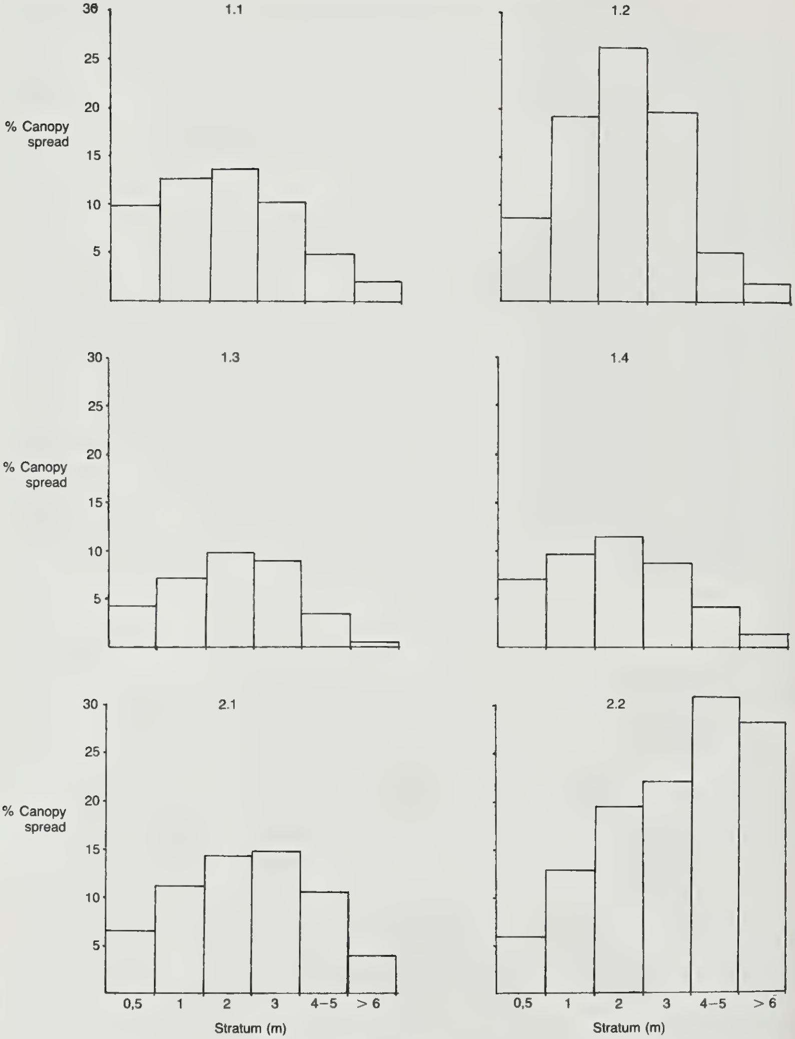

FIG. 9.
A diagrammatic presentation of the total percentage canopy spread in different strata of woody plant species of the Sandveld communities

1.1 The *Burkea africana—Pseudolachnostylis maprouneifolia* tree savanna
1.2 The *Baphia massaiensis—Guibourtia conjugata* thicket
1.3 The *Xeroderris stuhlmannii—Combretum apiculatum* tree savanna
1.4 The *Terminalia sericea—Pogonarthria squarrosa* tree savanna
2.1 The *Kirkia acuminata—Afzelia quanzensis—Combretum apiculatum* tree savanna
2.2 The *Androstachys johnsonii—Croton pseudopulchellus* dry forest

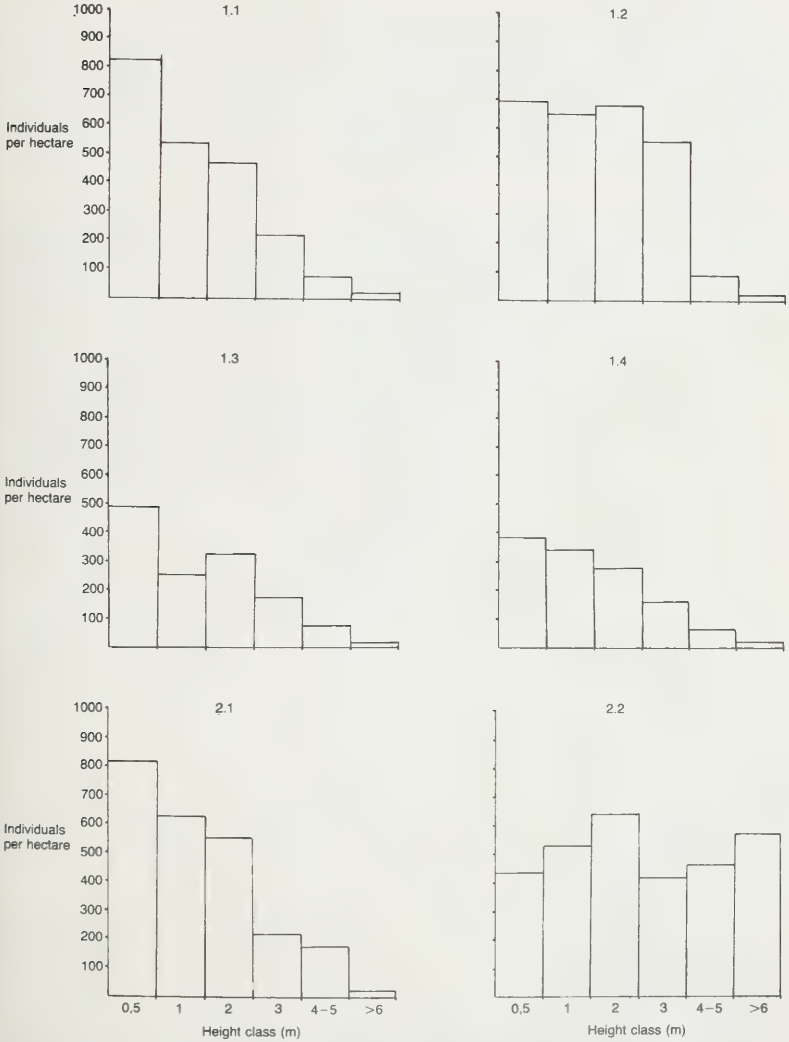

FIG. 10.

A diagrammatic presentation of the mean total individuals per hectare in different height classes of woody plant species in the Sandveld communities

1.1 The *Burkea africana—Pseudolachnostylis maprouneifolia* tree savanna
1.2 The *Baphia massaiensis—Guibourtia conjugata* thicket
1.3 The *Xeroderris stuhlmannii—Combretum apiculatum* tree savanna
1.4 The *Terminalia sericea—Pogonarthria squarrosa* tree savanna
2.1 The *Kirkia acuminata—Afzelia quanzensis—Combretum apiculatum* tree savanna
2.2 The *Androstachys johnsonii—Croton pseudopulchellus* dry forest

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References

Boucher, C., 1977. Cape Hangklip area. 1. The application of association-analysis, homogeneity functions and Braun-Blanquet techniques in the description of South-western Cape Vegetation. *Bothalia* **12**: 293–300.

Bredenkamp, G. J., 1975. *'n Plantsosiologiese studie van die Suikerbosrandnatuurreservaat*. M.Sc. thesis. Pretoria: University of Pretoria.

Coetzee, B. J., 1972. *'n Plantsosiologiese studie van die Jack Scottnatuurreservaat*. M.Sc. thesis. Pretoria: University of Pretoria.

Coetzee, B. J. and Gertenbach, W. P. D., 1977. Technique for describing woody vegetation composition and structure in inventory type classification, ordination and animal habitat surveys. *Koedoe* **20**: 67–75.

Dansereau, P., 1951. Description and recording of vegetation upon a structural basis. *Ecology* **32**: 172–229.

Farrell, J. A. K., 1968. Preliminary notes on the vegetation of the lower Sabi-Lundi Basin, Rhodesia. *Kirkia* **6**: 223–248.

Glover, P. E., 1968. The role of fire and other influences on the savannah habitat, with suggestions for further research *E. Afr. Wildl. Jnl.* **6**: 131–138.

Kershaw, K. A., 1964. *Quantitative and dynamic ecology*. London: Edward Arnold.

Reparticao Tecnica de Estatistica, 1961. *Boletim mensal das Observacoes Meteorologicas organizado pelo servico meteorologico*. Lourenco Marques: Imprensa Nacional de Mocambique.

Schulze, B. R., 1947. The climate of South Africa according to the classifications of Köppen and Thornthwaite. *S. Afr. geogr. J.* **29**: 32–42.

Schulze, B. R., 1965. *Climate of South Africa*. Part 8. *General survey*. W.B. 28. Pretoria: Government Printer.

Tinley, K. L., 1969. Dikdik *Madoqua kirkii* in South West Africa: Notes on the distribution, ecology and behaviour. *Madoqua* **1**: 7–33.

Van Rooyen, N., 1978. *'n Ekologiese studie van die plantgemeenskappe van die Punda Milia—Pafuri—Wambiyagebied in die Nasionale Krugerwildtuin*. M.Sc. thesis. Pretoria: University of Pretoria.

Van Rooyen, N., Theron, G. K. and Grobbelaar, N., 1981a. A floristic description and structural analysis of the plant communities of the Punda Milia—Pafuri—Wambiya area in the Kruger National Park: 1. The Hygrophilous communities. *Jl S. Afr. Bot.* **47**(2): 213–246.

Van Wyk, P., 1972. *Trees of the Kruger National Park*. Vol. 1. Cape Town: Purnell.

Van Wyk, P., 1974. *Trees of the Kruger National Park*. Vol. 2. Cape Town: Purnell.

Van Zinderen Bakker, Jr., E. M., 1971. *Ecological investigation on ravine forests of the Eastern Orange Free State (South Africa)*. M.Sc. thesis. Bloemfontein: University of the Orange Free State, Bloemfontein.

Walker, B. H., 1976. An approach to the monitoring of changes in the composition and utilisation of woodland and savanna vegetation. *S. Afr. J. Wildl. Res.* **6**: 1–32.

Weather Bureau., 1954. *Climate of South Africa*. Part 1. *Climate statistics*. W.B. 19. Pretoria: Government Printer.

Weather Bureau., 1965. *Climate of South Africa.* Part 9. *Mean monthly rainfall to the end of 1960.* W.B. 29. Pretoria: Government Printer.

Werger, M. J. A., 1973. *Phytosociology of the Upper Orange River Valley, South Africa: A syntaxonomical and synecological study.* Doctors proefschrift. De Katholieke Universiteit te Nijmegen, Nederland. Pretoria: V & R.

Werger, M. J. A., 1974. On concepts and techniques applied in the Zürich-Montpellier method of vegetation survey. *Bothalia* **11**: 309–323.